**Alkali Metals**

* They are very similar in properties than any other group
* Elements are
  + Lithium (Li) - red
  + Sodium (Na) - yellow
  + Potassium, (K) - lilac
  + Rubidium (Rb) - red
  + Cesium (Cs) -blue
  + Francium (Fr)
* Valence electron configurations: ns1, where n is period number
  + Francium is radioactive and doesn’t follow rule
* **PHYSICAL PROPERTIES**
  + **APPEARANCE:** silver-colored metals. Soft.
  + **OCCURRENCE:** too reactive to be found free/pure in nature
    - Sodium is found commonly in salt
  + Soft
  + Low melting point
    - Decreases as it goes down
  + Low density
    - Increases as it goes down
* **CHEMICAL PROPERTIES:**
  + **REACTIVITY:** highly reactive.
    - Increases from lithium to cesium (as it goes down)
    - **WITH WATER:** increases also (as it goes down)
  + They have weak metallic bond
  + **IONIC RADII:** smaller than atomic radii
    - **RADII:** increases as it goes down
  + Reacts with water to form hydrogen and alkali hydroxide
  + **OXIDATION STATE:** +1 or 0 (neutral)
  + **IONIZATION ENERGY**
    - First is low
    - Second is higher
    - Decreases as it goes down the group
* **INDUSTRIAL INFO:**
  + Sodium hydroxide, chloride and carbonate are importante industrial chemicals

**Alkaline Earth Metals**

* Electron Configuration ending in Ns2 (where N = energy level)
* All metals (shiny, silvery-white color)
* Highly reactive, but not as high as alkali metals
* Occurrence
  + Found in Earths crust (Radium does not occur free in nature – radioactive)
  + Rarely found as elements
  + Found as minerals distributed through rock structures (limestone and chalk (Ca)
  + Mg = 8th most abundant element in earths crust, Ca = 5th
  + Only Magnesium is produced on large scale – extracted from Sea Water
    - Used in tracer bullets, flares, incendiary bombs, alloyed (with aluminum) for use in aircrafts.
    - MgO has such a high M.P. that it’s used in furnaces
* Due to 2 valence electrons:
  + Stronger metallic bonding than alkali metals
  + Harder and more dense than alkali metals
  + Higher melting points than alkali metals
* Colors from a flame
  + Mg – brilliant white
  + Ca – brick-red
  + Sr – crimson
  + Ba – apple green
* Chemical Properties
  + Strong Reducers – easily oxidized
    - Mg 🡪 Mg2+ + 2e- (alkali metal oxidized)
    - Reduces other materials
  + Once initiated (started) reactions with Chlorine and Oxygen are vigorous
    - With Cl – forms ionic compounds
    - With O – forms basic oxides
      * Dulls the surface of the meal when oxides are made
  + In strong acidic solutions dilute the acid to hydrogen
    - Mg + 2 HCl 🡪 MgCl2 + H2
  + Can reduce and form compounds with Nitrogen (Mg3N2), hydrogen (CaH2), carbon dioxide (MgO + C)
    - Which means that fires of Mg cannot be extinguished with carbon dioxide fire extinguishers
  + Formation of hydroxides: Ca(OH)2, Sr(OH)2, Ba(OH)2 = basic
  + Almost always (with few exceptions) have a +2 oxidation number

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| --- | --- | --- |
| **Increasing Trends**  **(Be is highest)** | **Decreasing Trends**  **(Ra is lowest)** | **Alkaline Earth Elements** |
| Electronegativity  Ionization Energy   * 1st, 2nd, 3rd, 4th   Reactivity  Oxidizing Ability  Reduction Potential | Melting Point (Up and down)  Boiling Point  Atomic Radii  Ionic Radii  Atomic Number  Atomic Mass  Boiling Point  Density | Be – Beryllium |
| Mg – Magnesium |
| Ca – Calcium |
| Sr – Strontium |
| Ba - Barium |
| Ra - Radium |

**Halogens**

**Halogens: Elements in group 17**

|  |  |  |
| --- | --- | --- |
| **Element Name** | **Symbol** | **Electron Configuration** |
| Fluorine | F | [He]2s22p5 |
| Chlorine | Cl | [Ne] 3s23p5 |
| Bromine | Br | [Ar]3d104s24p5 |
| Iodine | I | [Kr]4d105s25p5 |
| Astatine | At | [Xe]4f145d106s25p5 |

Physical Appearance:

* Fluorine – poisonous pale yellow gas.
* Chlorine – poisonous pale green gas.
* Bromine – a toxic brown liquid. Highly volatile.
* Iodine – shiny black, a solid. Forms a violet vapor when heated.
* Astatine – usually not found in nature.

Occurrence and Extraction:

* Too reactive to occur freely in nature.
* **Fluorine** – mined. Extracted then oxidized from fluorides to fluorine.
* Huge quantities of **chlorides** are found in sea water, lakes and subterranean brine walls. Obtained by: electrolysis of molten sodium chloride or brine.
* **Bromine** – also found as the bromide ion in sea water from which it is extracted.
* **Iodine** – mined as sodium iodate, is obtained by reaction with sodium hydrogen sulfite.

Chemical Properties:

* Ability to oxidase.
* Fluorine has the strongest oxidizing ability. Elements which combine with it have the highest possible oxidation number.
* Most elements react directly with chlorine, bromine and iodine; with decreasing reactivity going down the group.
* Often the reaction must be activated by heat or UV light.
* Chlorine, bromine and iodine are disproportionate in the presence of water and alkalis.
* **Oxides and Oxoacids:** 
  + There are no fluorine oxides because it is more electronegative than oxygen.
  + Chlorine, bromine, and iodine each form several oxides which are thermally unstable.
  + The only fluorine oxoacid, HOF, is unstable at room temperature.
  + There are many Oxoacids of the other halogens.
    - Chlorate, Chlorite and Hypochlorite.
* **Halides:**
  + Halogens can combine with each other to form interhalogens and polyhalide.
  + Polyhalide ions have the general formula [Y-X-Y].
    - Not possible for F to represent X in a polyhalide as it cannot expand its octet.
* **Hydrides:** 
  + Hydrogen halides formula – HX.
    - HF is a colorless liquid which boils at 19.5C. A liquid due to the extensive hydrogen bonding.
    - All other hydrogen halides are colorless gases.
    - Hydrogen halides dissolve easily to give acidic solutions, such as HCl.
    - All except HF are typical acids. HF is a weak acid because of the bonding.
* **Organic Compounds:** 
  + These compounds that halogens form are best known for their industrial and environmental impact such as PVC, DTT and TCP.

General Reactivity

* They all exist as diatomic molecules (X2) and oxidase metals to form halides
* Halogen oxides are acidic
* Hydrides are covalent
* F is the most electronegative element
* Electronegativity and oxidizing ability decreases as it goes down the group
* The decrease in electronegativity increases in covalent character
* F shows anomalies due to its small size of atom and ion
  + Allows several F atoms to pack around a different atom
  + The F-F bond is weak since:
    - Small size of atom
    - The small size brings lone pairs closer to each other, than in other halogens
    - Repulsion weakens the bond

Physical Properties

* At room temperature all halogens are diatomic molecules
* Melting point, boiling point, atomic radii, and ionic radii all increase as going down the group
* Fluorine is never surrounded by more than 8 electrons, but the other halogens can be surrounded by up to 14 electrons

Oxidation states and Electron Affinities

* Fluorine has a oxidation number of -1, since it’s the most electronegative
* Other halogens have a wide range of oxidation numbers
* Most oxidation numbers are odd, and if even they are thermally unstable
* Cl is the 3rd most electronegative element after F, and O
* Halide ions are formed by accepting one electron
* Electron affinity decreases as it goes down the group

Industrial Information

* F is widely used as an oxidizing agent
* HF is used to scratch glass
* Cl is used for chlorinating drinking water
* Chlorine dioxide is used to bleach wood pulp for paper making
* Hypochlorites are used in domestic bleaches
* Potassium chlorate is used as an oxidant in fireworks and matches

**Noble Gases**

**Noble Gases**

* All non-metal in gas state
  + Least metallic properties
  + Found very rarely
  + Boil at very low temperatures
  + Little attraction between the atoms
* Small Atomic Radii
* Full valence shells
  + Most stable (least reactive) elements
    - Considered unreactive
  + High electronegativity
  + High Ionization Energy
* He, Ne, and Ar are not know to form any compounds (oxidation number 0)
  + Kr forms KrF2
  + Xenon bonds with oxygen and fluorine (+2, +4, +6, +8)

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| --- | --- | --- |
| **Trends that Increase Going Down the Group** | **Trends that Decrease Going Down the Group** | **Elements in the Period** |
| Atomic radius | First Ionization Energy | He |
| Density | Electron Affinity | Ne |
| Melting Point |  | Ar |
| Boiling Point |  | Kr |
| Freezing Point |  | Xe |
|  |  | Rn\* |

\*Radon is hazardous and radioactive